4. REMEDIAL DESIGN

This section in the remedial design is presented in terms of the design assumptions, design criteria, technical elements, and quality assurance.

4.1 Design Assumptions

The following general assumptions are limiting factors and conditions under which the remedial design for the Group 2 sites was developed.

- There are no criticality issues associated with the V-Tanks and the remedial activities described in this RD/RA WP.
- No groundwater will be encountered during tank or contaminated soil excavation.
- Historical sample data are representative of the physical properties of the sludge and the contamination to be encountered in all media.
- The tank locations, orientations, and dimensions are as presented in INEEL engineering drawings.
- Tanks are made of ¼-in. thick stainless steel, and the structural integrity is intact.
- The depth of excavation will be to the spring line of the tanks.
- The top of Tank V-9 is 7-ft bgs. The base of the tank is approximately 14-ft bgs.
- Piping and utilities are as presented in available INEEL engineering drawings.
- Piping to be removed is stainless steel, and the structural integrity is intact.
- The tank sludge has not hardened to a cement-like form; the sludge can be suspended in water by mechanical action or low-intensity shear forces.
- Onsite average dry soil density is 95.5 pounds per cubic foot.
- Disposal facilities will be available for all waste streams that will be generated.
- Sludge disposal facility (ATG) will limit Sr-90 to less than or equal to 4 curies of activity per package.
- If the limitations for Sr-90 are met, then limitations that the sludge disposal facility (ATG) has for other radionuclides will also be met.
- Shipping cask requirements will limit the amount of fissile material to less than 15 grams per container.
- Envirocare's waste acceptance criteria are representative of radionuclide disposal requirements for determining the level of treatment required for contaminated water.

4.2 Design Criteria

The design criteria provide the framework and basis for the technical design elements necessary to achieve the remedial action. The sizing and design of the technical elements are controlled by the design criteria. The design criteria associated with TSF-09, TSF-18, and the non-CERCLA components are as follows.

- **Stormwater.** A two-year, 24-hour storm event will be used for sizing onsite runoff and offsite run-on flow control structures and for establishing the amount of contaminated runoff that will require management. A 25-year, 24-hour storm event will be used for sizing secondary containment structures.

- **Shoring Loading.** All shoring used for earthwork must have a minimum capacity of 671 pounds per square foot (Appendix C, ABQ05-CE001).

- **Secondary Containment.** Secondary containment areas must be able to contain a 25-year, 24-hour storm plus either 100% of the largest container or 10% of the total container volume, whichever is greatest (Appendix C, ABQ08-CE004).

- **Personnel Dose Limitations.** The dose rate goal for general work areas outside of high radiation zones is less than 10 mR/hr. Personnel and project ALARA goals will be established by a radiological engineer.

- **Waste Packaging.** Department of Transportation requirements specified in 49 Code of Federal Regulations (CFR) Subchapter C, Hazardous Materials Regulations, will be met. Maximum activity for Sr-90 will be 4 curies per package to satisfy the current sludge disposal facility's (ATG) restriction.

- **Water Treatment.** Treated water must meet land disposal restrictions and the disposal facility's waste acceptance criteria before solidification.

4.3 Technical Elements

The technical elements of the design represent the physical components of the design that are required to be in place and functional during the remedial action. Detailed drawings, specifications, and calculations supporting the design are located in Appendices A, B, and C, respectively. A description of each major technical element and its respective function follows.

4.3.1 Onsite Drainage Control

Onsite drainage control is designed to control contaminated water within the contaminated area and restrict contaminated water from running offsite. A containment berm around the perimeter of the contaminated area will restrict offsite flows. Stormwater will be allowed to collect in multiple areas onsite in an attempt to limit the amount of stormwater that will have to be managed; therefore, no focused collection point for onsite stormwater has been designed. Any onsite runoff that collects at the berm and in other areas of the site, and that does not infiltrate into the ground within 24 hours of the storm event, will be pumped and stored onsite for subsequent treatment, as required.

4.3.2 Offsite Drainage Control

Offsite drainage control is designed to restrict offsite stormwater from running across the contaminated site and becoming contaminated. Restricting the amount of stormwater run-on minimizes the amount of contaminated water that must be managed. Protective controls include gutters and drain spouts installed on all building roofs that drain onto the site. Drain spouts will be extended to direct stormwater outside of the controlled contamination area. Perimeter control ditches will direct stormwater run-on around the site. Stormwater that cannot be diverted around the site will be directed through the site in a buried 21-in. corrugated metal culvert so the water does not become contaminated.

4.3.3 Access Control

A 6-ft high perimeter fence will control access to the site so only trained and authorized personnel are able to access the contaminated site. All personnel will access the site and leave the site through access controls that will be set up. Equipment access will be through the north end of the site. Equipment used onsite during the remediation is expected to remain onsite until remediation is complete. An additional access control point at the southeast corner of the site will allow access to the stack designated as TAN-734 for maintenance purposes. This access is expected to be needed on a limited basis. Any personnel using this access control point will come through the access control point first and obtain the appropriate personal protective equipment.

High radiation areas in the drum and high-integrity container (HIC) storage areas will be controlled with an additional 6-ft high perimeter fence so that only the necessary personnel have access to these areas. The AOC boundary around the V-Tanks establishes the boundary within which hazardous material contamination needs to be controlled so that it is not spread to other areas of the contaminated site. The northern end of the boundary is the point where all visible hazardous contamination will be removed from personnel and equipment before access to the rest of the site can be obtained.

4.3.4 Drum Storage/Water Storage/Decontamination Area

The Drum Storage/Water Storage/Decontamination Area provides the secondary containment necessary for the dewatered sludge drums and the contaminated water that will be stored in this area. Shielded overpacks will be installed over the dewatered sludge drums. The use of shielded overpacks for the drums will allow this area to be only a radiation area. Drums will be transferred to interim storage as soon as practical to minimize exposure rates and maintain site dose rate ALARA. The area will serve a dual purpose at the end of the remediation and will function as the equipment decontamination area. A concrete sump within this area will provide the secondary containment for decontamination water that is collected and will be pumped, as required, during decontamination activities.

4.3.5 HIC Storage/Drum Filling, Staging Area

The HIC Storage/Drum Filling Staging Area will be considered a high radiation area. It provides the secondary containment and the area necessary to store HICs. It also provides the operational area necessary to allow for sludge transfer from the HICs to the drums and subsequent dewatering of the drums before moving them to the drum storage area.

4.3.6 Soil Bag/Debris/Tank Storage Area

The Soil Bag/Debris/Tank Storage Area provides the space where filled soil bags or rolloffs, containerized debris, and empty V-Tanks will be stored prior to transfer to a disposal facility. Soil bags will be stacked up to three in this area. Secondary containment will not be required for this area because no liquid waste will be stored in this area. This area will be considered a radiation area or radioactive material storage area and will be controlled only with a 4-ft access control fence to designate the boundaries of the storage area.

4.3.7 Radiation Shielding

Radiation shielding will be provided around the perimeter of the high radiation areas to limit the dose exposure in the general work areas. Shielding equivalent to 10 in. of concrete is expected to be required and will be provided, as required, to limit dose exposures to within the design criteria. Filled soil bags, rolloffs, or concrete blocks are examples of shielding that can be used. Sludge drums will be stored in lead-shielded overpacks.

4.3.8 Shoring

Shoring (trench shielding or trench boxes) or side sloping will be required for all excavations that exceed 4 ft in depth to protect workers from soil cave-ins. Premanufactured trench shields will be used to provide the shoring protection, as required, for the excavation of the V-1, V-2, V-3, and V-9 tanks. The shoring for the tanks will remain in place after the tank removal to allow soil sampling and analysis to occur and will then be removed during backfill operations. Shoring will not be left in place for the utility line excavations.

4.4 Process Description

The process for removal of water and sludge from four V-Tanks is presented in Figures 4-1 through 4-5. This process, including treatment of the water faction, is illustrated in Figure 4-1. The sludge will then be transferred to drums and dewatered, with the water being removed and treated as illustrated in Figure 4-3. The treated water from these steps will be collected in storage containers. The design anticipates this water will be acceptable for disposal, but if testing indicates otherwise, the water will be retreated as illustrated in Figure 4-5. Each of these processes is described in further detail in the following sections.

4.4.1 V-Tank Sludge Removal/Water Treatment

This is a three-step process as shown in Figure 4-1. First, the excess water from Tank V-3 will be removed and treated. Second, the sludge contents of the V-Tanks will be removed and placed in the sludge HICs. This will be done using a self-priming peristaltic pump with a moveable suction line. Water will be recycled under pressure to the respective V-Tank, as needed, to fluidize the sludge solids and aid in their removal. In the third step, the water that remains in the tanks after the sludge removal will be treated through the sequence of units shown. Water removed from the tanks during this third step will only pass through the treatment train one time.

Figure 4-2 presents a mass balance for each of the V-Tanks showing flow rates, volumes, and contaminant concentrations for each step through the process. The stream numbers shown in the diamonds correspond to the columns in the mass balance tables. Each is further described as follows:

- No. 1 is the transfer of sludge and water from the V-Tank to the sludge HIC.
- No. 2 is the transfer of water from the sludge HIC to the oil and grease filter.

- No. 3 is the flow of water from the oil and grease filter to the first stage granular-activated carbon (GAC) unit. Oil and grease content have been reduced to ≤ 1 mg/L and total suspended solids (TSS) have also been reduced to ≤ 5 mg/L.

- No. 4 is flow from the 1st to the 2nd stage GAC unit. It shows various organics have been reduced, TOC has been reduced by 95%, and oil and grease have been reduced to <0.1 mg/L.

- No. 5 is the flow from the 2nd stage GAC unit to a bag filter. It shows additional removal of individual organics to <0.01 mg/L and TOC to <0.5 mg/L.

- No. 6 is flow from the bag filter to the ion exchange unit. The bag filter traps carbon fines that may wash through the GAC units.

- No. 7 is flow from the ion exchange unit to the day tank. It shows 95% removal of the heavy metals and a greater than 90% reduction in radioactivity. Incidental removal of heavy metals and radioactivity may have occurred in the upstream units, but all removal has been assumed to occur in the ion exchange unit.

- No. 8 represents treated water flowing to the water HIC.

- The bypass allows untreated water to be returned to the V-Tank to aid in pumping out the sludge and will be used on an as needed basis.

In the case of Tank V-1, the first column shows that the average pumping rate is estimated to be 10 gpm, and the total volume to be removed is 1,684 gal. Sampling results show that two metals and two VOCs exceed the LDR treatment standards. The TOC listed is the measured TOC and includes the summation of other detected organic compounds that were less than the LDR standards and the semivolatiles at detection limits that exceed the LDR standards. The remainder of the table represents the contaminant levels at each step of the water treatment process. For the equipment selected, the flow rate is limited to 10 gpm per treatment train, and the total volume to be treated is 644 gal, based on the assumption that 520 gal of water will remain with the sludge to create a 50/50 mixture of sludge/water in the sludge HIC.

The sludge HIC is equipped with a filter with a pore size equivalent to 10 μm that will retain suspended particles and prevent clogging of downstream units. The first filter, F1, will absorb any oil that may be present and provide additional removal of suspended solids. The next two units, CH, are 55-gal granular-activated carbon (GAC) adsorbers to remove organic contaminants. Published isotherms (found in the *EPA Treatability Manual*, EPA-600/8-80-042a) were used to estimate carbon consumption. The GAC isotherms give the quantity of contaminant adsorbed per unit of carbon for a given residual remaining in the water. The units are typically milligrams of adsorbed contaminant per gram of carbon. In the case of TCE for a residual 0.01 mg/L, 2 mg is adsorbed per gram of GAC, or 0.002 lb/lb of GAC. A total of 644 gal of water containing 0.16 mg/L of TCE represents 0.859 (10^{-3}) lb of TCE, and dividing by 0.002 gives 0.43 lb of GAC consumed to treat this water. For PCE, the consumption factor is 0.0038 lb/lb of GAC at 0.01 mg/L, and 0.20 lb of GAC will be consumed in removing this contaminant. The other organics were estimated to consume 0.40 lb GAC and the remaining TOC was estimated to consume 25.13 lb of GAC. This is a simplified but conservative approach to what happens in a GAC column with water flowing through it. The residual of 0.01 mg/L was selected at well below the LDR standard and with 165 lb of GAC in each unit, the effluent from the first will be 0.02 mg/L or less for each contaminant and <0.01 mg/L after the 2nd stage unit.

Ion exchange was selected to remove heavy metals. A standard water softener using cationic resin regenerated with salt is suitable for this application. The ionic loading is primarily from calcium, magnesium, and potassium. Since the resin is in the sodium form, sodium in the water will have no impact on the resin. However, the relatively low concentrations of the heavy metals of concern will be efficiently removed because the resin has much higher affinity for these metals. The mass balance shows a conservatively estimated removal of 95% for the metals of concern. Cationic radionuclides will also be removed. Converting those present above the detection level to mg/L concentrations shows uranium to be less than 0.9 mg/L, and all the others combined are less than 0.0001 mg/L. Ion exchange resin has a strong affinity for high molecular weight ions, so these ions will be, essentially, completely removed and the radioactivity due to the strontium-90 and cesium-137 are conservatively estimated to be reduced 90%. Ion exchange loading is expressed as calcium carbonate ($CaCO_3$) equivalents. The loading for the water from Tank V-1 is 2.042 lb as $CaCO_3$ including 0.002 lb from radionuclides.

The process for Tank V-2 is similar to that described for Tank V-1. The volume of water to be treated is 556 gal, and it contains only TCE at a level above the LDR standard. GAC consumption for treating the TCE is 0.67 lb, and the estimated quantity for the other organics above detection limits is 1.5 lb. GAC consumption for the remaining TOC is 34.53 lb. The ion exchange loading is 1.804 lb as $CaCO_3$ with 0.004 lb from radionuclides.

For Tank V-3, the water volume treated is 6,995 gal with TCE the only contaminant above the LDR standard (Figure 4-2). Carbon consumption for TCE treatment will be 5.8 lb and approximately 13.0 lb for other organics above detection limits. The remaining TOC will consume 434.32 lb. After treating approximately 4,100 gallons of this water, the first stage GAC units from each train should be removed and new units installed in the 2nd stage. The ion exchange loading is 17,985 lb as $CaCO_3$ with 0.015 lb from radionuclides.

Tank V-9 contains more sludge than water, so water removed from the other tanks will need to be added to this tank to fluidize the sludge for removal. The water added will remain mixed with the sludge in the sludge HIC tank.

To summarize, water treatment associated with emptying the V-Tanks will consume a total of 516 lb of GAC and result in an ion exchange loading of 22 lb as $CaCO_3$.

4.4.2 Drum Filling/Water Treatment

Figure 4-3 shows the drum filling and water treatment process flow diagram along with the operating logic. Each sludge HIC will be subject to this operation. After a drum is filled with the sludge and water mixture, the water will be withdrawn and treated with the same equipment used previously for emptying the V-Tanks. A composite mass balance for this operation is presented in Figure 4-4. Although each sludge HIC will be processed separately, the mass balance for water treatment has been calculated as a composite. This results in a conservative estimate of GAC consumption as long as the Tank V-9 sludge with the higher concentrations is processed last. The total mixed volume is 3,706 gal, and the quantity of water extracted from the drums is 1,763 gal. To obtain the composite concentration of each parameter, the volume multiplied by the concentration for each sludge HIC was summed and the total divided by 3,706 gal to create a weighted average.

GAC consumption was calculated as described previously, except for three VOCs present at significantly higher concentrations. For TCE, 1,1,1-TCA, and methylene chloride, the calculation was done step-wise to simulate the removal process in a flow-through system. When a high concentration enters the bed, the top layer reaches equilibrium with this concentration and adsorbs a large portion of the compound. As the reduced concentration moves down to the next layer, a new equilibrium is established based on the reduced concentration. This is repeated until the entire compound is removed, or the available GAC is consumed and breakthrough occurs. In the case of TCE, the GAC consumption was calculated first at 10 mg/L, then 1 mg/L, and the remainder at 0.01 mg/L, giving 3.06, 7.01, and 7.79 lb, respectively, for a total of 17.86 lb. 1,1,1-TCA was calculated at 1 and 0.01 mg/L, and the methylene chloride was calculated at 1, 0.10, and 0.01 mg/L. The total GAC consumption for treating the drum filling water is 354.5 lb. With 187.5 lb used previously for the V-Tank water treatment, 132.5 lb GAC remains available in the 1st stage units for drum filling. This operation will consume approximately 1 lb of GAC for every 5 gallons of water treated. Therefore, after 500 to 600 gallons have been processed, the 1st stage units need to be removed and two new units provided for the 2nd stage with the units used previously in the 2nd stage becoming 1st stage units. After completing the drum filling water treatment, a total of 8 GAC units will require disposal.

The two oil and grease filters should last for the entire activity and will require disposal when all treatment is completed. The bag filters are also expected to last for the full treatment cycle and will require disposal when completed.

The ion exchange loading from drum filling water treatment is 21.36 lb as $CaCO_3$, including 1.04 lb from radionuclides. The total loading to the ion exchange system for all water treatment is 43.191 lb as $CaCO_3$ per cubic foot. Strong acid cation resin in the sodium form has an exchange capacity of 2.14 lb as $CaCO_3$. The quantity of resin exhausted then is 20.2 ft^3. The ion exchange unit for each train will contain 24 ft^3 of resin, which will require disposal after the treatment process has been completed.

Figure 4-5 shows a contingency water treatment process similar to those described previously. No mass balance is presented because it is believed that, after the first treatment, the water will meet LDR standards. Should testing indicate otherwise, then this process will be activated with the water being circulated back to the water storage tank(s). This will continue until testing proves that the LDR and WAC standards are met.

After water within the containers has been treated to meet the TSDF's WAC and LDRs, a solidification agent will be added to the container, as recommended by the manufacturer or the agent. It is expected that approximately 4 lb of agent will be used. The actual amount of agent to be used will be confirmed with a small bench-scale pilot test using a sample of the actual liquid that will be solidified. The amount of agent to be used will be adjusted until the degree of solidification expected is obtained. Mixing of the liquid with mechanical agitation after addition of the solidification agent is not required; however, mixing will accelerate the solidification process and may be used depending on results of the bench scale test.

4.5 Quality Assurance

A safety category evaluation (formerly called a quality level designation), included as Appendix E, has been prepared for all structures, systems, and components of the remediation. The evaluation was performed in accordance with Management Control Procedure (MCP)-540, "Documenting the Safety Category of Structures, Systems, and Components" (Revision 13). A Bechtel BWXT Idaho, LLC Quality Level 3-facility designation has been deemed appropriate for this project. A Quality Level 3 is equivalent to a Low Safety Consequence (LSC) classification. The majority of project components have been evaluated as LSC. The Price-Anderson Amendment Act requirements apply to this remediation.

The Group 2 RD/RA WP will comply with the quality assurance/quality control criteria and requirements stated in the quality assurance project plan entitled *Quality Assurance Project Plan for Waste Area Groups 1, 2, 3, 4, 5, 6, 7, 10, and Inactive Sites* (DOE-ID-2000d) for sampling and data management.

A Subcontractor Quality Plan for the remediation effort has been prepared in accordance with program requirements document (PRD)-5006, "Subcontractor Quality Plan" (WESTON 2001c). The Subcontractor Quality Plan addresses how design inputs, analyses, verifications, outputs, and changes are controlled and followed.

FILE NO. G:\ACADPROJ\12393002001NEEL\FIGURE1A.dwg

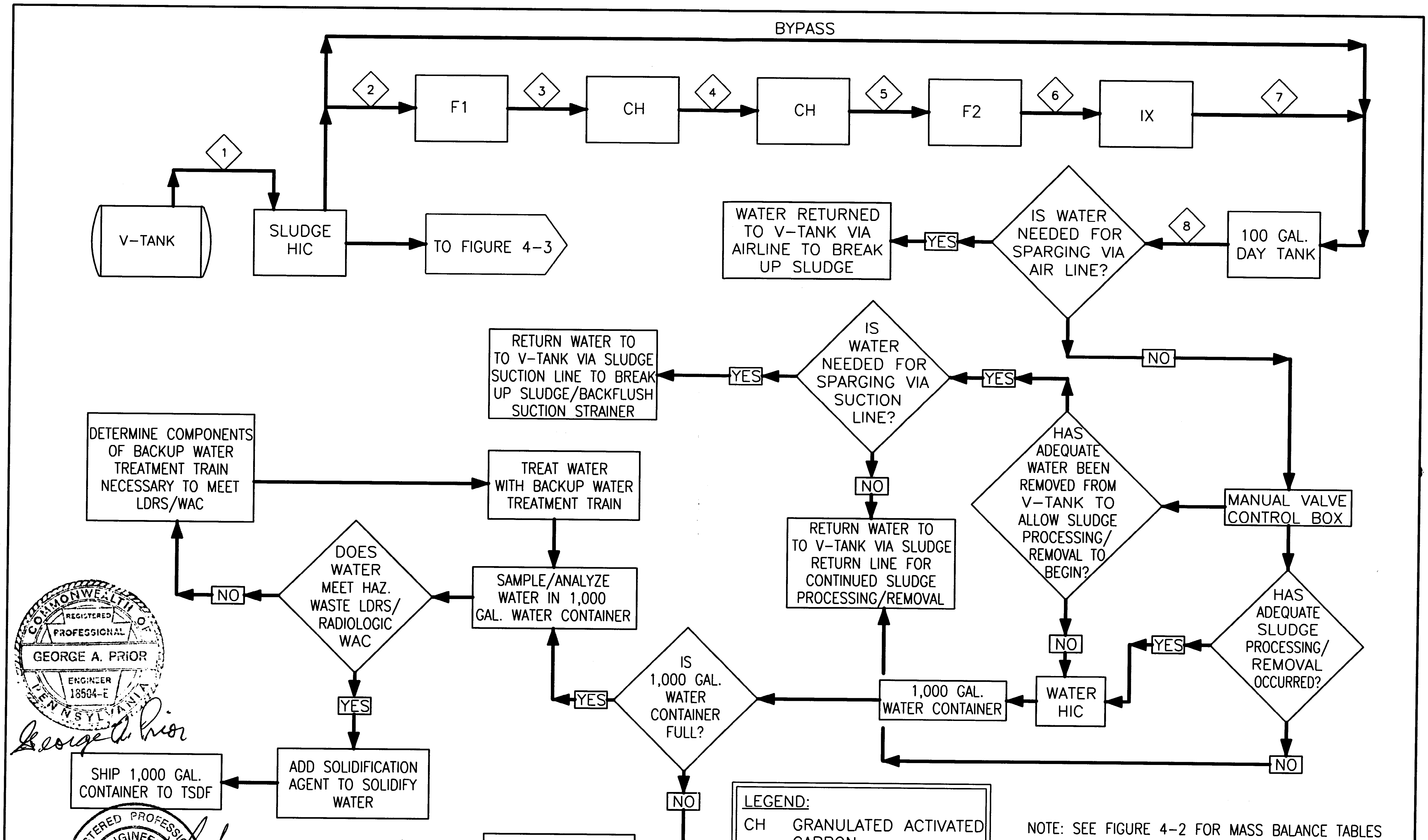
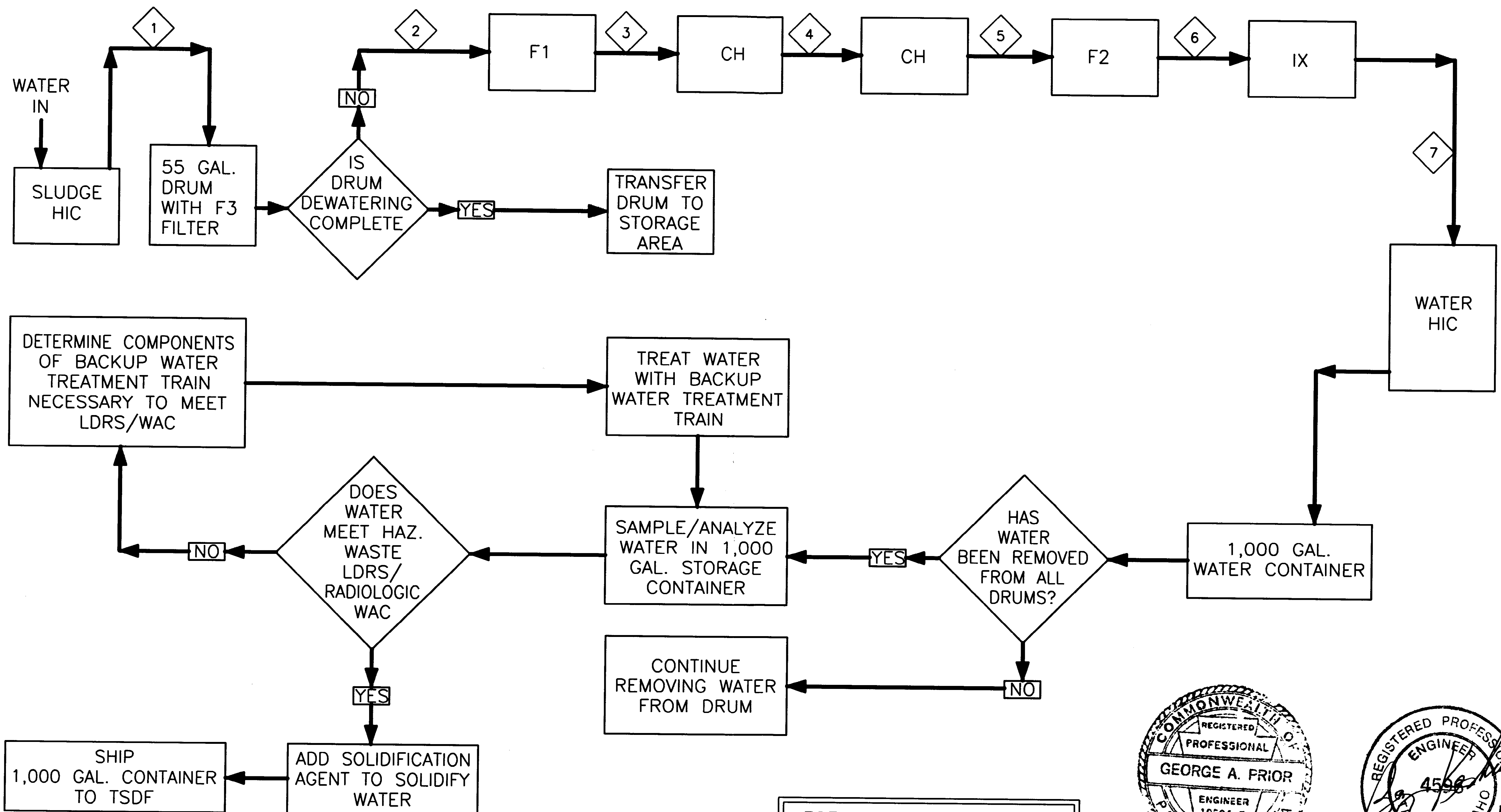


FIGURE 4-1.

V-TANK SLUDGE REMOVAL/WATER TREATMENT PROCESS FLOW DIAGRAM



LEGEND:

CH	GRANULATED ACTIVATED CARBON
FI	OIL & GREASE FILTER
F2	1 MICRON BAG FILTER
F3	BARTLETT FILTER, 20x2 POLYPROPYLENE ELEMENT
IX	ION EXCHANGE

COMMONWEALTH OF PENNSYLVANIA REGISTERED PROFESSIONAL GEORGE A. FRIOR ENGINEER 18504-E

George A. Prior

REGISTERED PROFESSIONAL ENGINEER 4598 STATE OF IDAHO BERG KESHIAN JR

11/15/01

NOTE: SEE FIGURE 4-4 FOR MASS BALANCE TABLE

FIGURE 4-3.

V-TANK DRUM FILLING AND DEWATERING PROCESS FLOW DIAGRAM

FILE NO. G:\ACADPROJ\12393002001INEEL\FIGURE3A.dwg

DRUM DEWATERING COMPOSITE MASS BALANCE

STREAM NO.		1	2	3	4	5	6	7	LDR WASTEWATER TREATMENT STANDARD
STREAM DESCRIPTION		F3	F1	CH	CH	F2	IX FEED	WATER HIC FEED	
FLOW RATE	GPM	10	10	10	10	10	10	10	–
VOLUME,	GAL	3706	1763	1763	1763	1763	1763	1763	–
LEAD	mg/L	0.317	0.317	0.317	0.317	0.317	0.317	0.016	0.69
MERCURY	mg/L	0.152	0.152	0.152	0.152	0.152	0.152	0.008	0.15
NICKEL	mg/L	1.194	1.194	1.194	1.194	1.194	1.194	0.060	3.98
CADMIUM	mg/L	0.132	0.132	0.132	0.132	0.132	0.132	0.007	0.69
TETRACHLOROETHENE,	mg/L	0.039	0.039	0.039	< 0.01	< 0.01	< 0.01	< 0.01	0.056
TRICHLOROETHENE	mg/L	35.602	35.602	35.602	1.80	< 0.05	< 0.05	< 0.05	0.054
METHYLENE CHLORIDE	mg/L	5.008	5.008	5.008	0.25	< 0.01	< 0.01	< 0.01	0.089
1, 1, 1-TRICHLORETHANE	mg/L	5.095	5.095	5.095	0.25	< 0.01	< 0.01	< 0.01	0.054
3, 3-DICHLOROBENZIDENE,	mg/L	0.0057	0.0057	0.0057	< 0.01	< 0.01	< 0.01	< 0.01	0.055
2, 4-DIMETHYLPHENOL,	mg/L	0.0068	0.0068	0.0068	< 0.01	< 0.01	< 0.01	< 0.01	0.036
INDENO	mg/L	0.0031	0.0031	0.0031	< 0.01	< 0.01	< 0.01	< 0.01	0.0055
2-METHYLPHENOL,	mg/L	0.0717	0.0717	0.0717	< 0.01	< 0.01	< 0.01	< 0.01	0.11
4-METHYLPHENOL,	mg/L	0.0717	0.0717	0.0717	< 0.01	< 0.01	< 0.01	< 0.01	0.77
PHENOL,	mg/L	0.0087	0.0087	0.0087	< 0.01	< 0.01	< 0.01	< 0.01	0.039
TOC	mg/L	85	85	85	4	< 0.5	< 0.5	< 0.5	VARIES
Sr-90	pCi/L	1.341 E + 07	6.70 E + 06	6.70 E + 06	6.70 E + 06	6.70 E + 06	6.70 E + 06	6.70 E + 05	–
Cs-137	pCi/L	7.369 E + 06	6.13 E + 06	6.13 E + 06	6.13 E + 06	6.13 E + 06	6.13 E + 06	6.13 E + 05	–
OIL & GREASE	mg/L	2.96	2.96	1.00	< 0.1	< 0.1	< 0.1	< 0.1	–
TOTAL SUSPENDED SOLIDS	mg/L	–	32.1	1	< 1	< 1	< 1	< 1	–
SPECIFIC GRAVITY		1.02	1.00	1.00	1.00	1.00	1.00	1.00	–

LEGEND:

CH	GRANULATED ACTIVATED CARBON
FI	OIL & GREASE FILTER
F2	1 MICRON BAG FILTER
F3	BARTLETT FILTER, 20x2 POLYPROPYLENE ELEMENT
IX	ION EXCHANGE

COMMONWEALTH OF PENNSYLVANIA
REGISTERED PROFESSIONAL
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ENGINEER
18504-E

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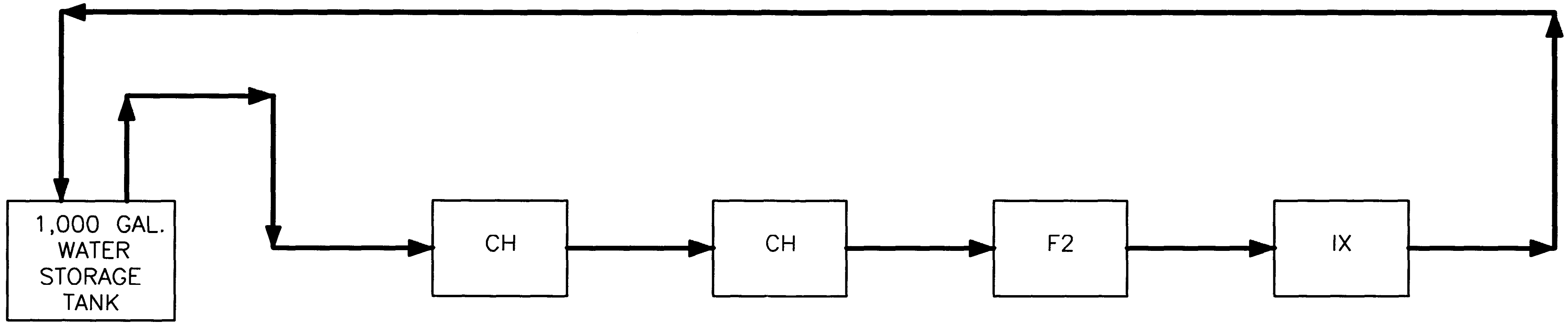
11/5/01

NOTE: SEE FIGURE 4-3 FOR PROCESS FLOW DIAGRAM

FIGURE 4-4.

V-TANK DRUM FILLING AND DEWATERING PROCESS FLOW COMPOSITE MASS BALANCE TABLE

FILE NO. G:\ACADPROJ\12393002001NEEL\FIGURE4A.dwg



LEGEND:

CH	GRANULATED ACTIVATED CARBON
F2	1 MICRON BAG FILTER
IX	ION EXCHANGE

COMMONWEALTH OF PENNSYLVANIA REGISTERED PROFESSIONAL GEORGE A. PRIOR ENGINEER 18504-E

REGISTERED PROFESSIONAL ENGINEER 4896 STATE OF IDAHO BERG KESHIAN IR

11/5/01

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FIGURE 4–5.

V–TANK BACKUP WATER TREATMENT PROCESS FLOW DIAGRAM

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